

What is claimed is:

1. An engine control system comprising:

an exhaust gas sensor having a sensor element that is provided with an electric heater for controlling temperature near the sensor element and appropriately operating at a predetermined activation temperature, measuring oxygen concentration of exhaust gas of the engine and outputting oxygen-concentration data, and outputting predetermined oxygen-concentration data when said exhaust gas is in an atmospheric air exchange state and the temperature near said sensor element is at the predetermined activation temperature;

a standard characteristic storage memory in which a functional expression or a data table showing a relation between said oxygen-concentration data and an air-fuel ratio of said engine at said predetermined activation temperature and oxygen-concentration data in the mentioned atmospheric air exchange state are stored;

atmospheric air judging means for judging an atmospheric air state to determine that said exhaust gas is in an atmospheric air exchange state that the exhaust gas has been exchanged with said atmospheric air when fuel supply to the mentioned engine has been stopped exceeding a predetermined time;

first heater control means that controls said electric heater so that said oxygen-concentration data coincide with the oxygen-concentration data stored in said standard characteristic storage memory when said atmospheric air state judging means judges that the exhaust gas is in the atmospheric air state;

calibration signal reading means that stores internal resistance of said exhaust gas sensor or internal resistance of said electric heater at the point of time when the oxygen-concentration data outputted by said exhaust gas sensor being controlled by said first heater control means comes to coincide to said standard value

data as a target internal resistance;

second heater control means that operates when fuel is supplied to said engine to control the foregoing electric heater so that a current value of said internal resistance of said exhaust  
5 gas sensor or the electric heater coincides to said target internal resistance; and

air-fuel ratio calculating means that has a microprocessor and calculates the current air-fuel ratio on the basis of the current oxygen-concentration data of said exhaust gas sensor controlled by  
10 said second heater control means and said functional expression or data table stored in said standard characteristic storage memory.

2. The engine control system according to claim 1, wherein said atmospheric air state judging means is provided with scavenging  
15 air judging means for judging that the exhaust gas in an exhaust pipe has been exchanged with said atmospheric air by detecting that an integrated value of an engine intake air amount or an integrated value of an engine speed exceeds a predetermined value under fuel-cut driving condition that fuel supply to said engine has been  
20 continuously stopped.

3. The engine control system according to claim 1, wherein said atmospheric air state judging means is provided with time lag detecting means for judging that a time lag from the time when a  
25 power supply switch for driving said engine is turned off to the time when said power supply switch is turned on exceeds a predetermined value and that said exhaust gas has been exchanged with the atmospheric air when said engine is stopped.

30 4. The engine control system according to claim 1, wherein

said calibration signal reading means includes moving average means that calculates an average value of predetermined numbers of latest target internal resistances among plural target internal resistances obtained every time said first heater control means is performed.

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5. The engine control system according to claim 1, wherein said exhaust gas sensor comprises:

a gas-detecting chamber that includes a gas passage wall composed of a gas diffusion porous material, an oxygen pump element  
10 composed of a zirconia solid electrolyte material, and an oxygen-concentration cell element, a part of the exhaust gas of said engine being permitted to pass through said gas-detecting chamber;

an oxygen reference generation current supply circuit for supplying an oxygen reference generation electric current to said  
15 oxygen-concentration cell element;

a pump current supply circuit for controlling a pump current of said oxygen pump element so that the oxygen concentration of said gas-detecting chamber comes to be an established value;

an internal resistance detecting circuit for detecting an  
20 internal resistance when a predetermined high-frequency current flows through said oxygen-concentration cell element;

a calibration resistor for compensating the oxygen-concentration data of said exhaust gas sensor at a predetermined activation temperature when said exhaust gas is in the atmospheric  
25 air state and calibrating so that the oxygen-concentration data of a first article of the exhaust gas sensor is equal to standard value data stored in said standard characteristic storage memory; and

an electric heater that is disposed near said gas-detecting chamber and activates and heats said gas-detecting chamber while  
30 monitoring the resistance detected by said internal resistance

detection circuit; and wherein

the oxygen-concentration data of the gas-detecting chamber is obtained by detecting said pump current.

5           6. The engine control system according to claim 1, wherein said microprocessor includes a program memory such as flash memory, a nonvolatile memory such as FEPR0M, and an arithmetic memory such as RAM memory;

          said standard characteristic storage memory includes said  
10 program memory or said nonvolatile data memory, and in which characteristic data are transferred from an external tool and written in said standard characteristic storage memory; and

          the engine control system further comprising data storing means in which a moving average value as to a target internal  
15 resistance value or target internal resistance stored in said arithmetic memory and used is evacuated and stored in said nonvolatile data memory when the engine is stopped.

          7. The engine control system according to claim 6, further  
20 comprising:

          initial value evacuating and transferring means that writes and stores a first stored value or an initial average stored value of the target internal resistance stored in said arithmetic memory in said nonvolatile data memory;

25           deterioration detecting means for judging that said exhaust gas sensor has deteriorated when a difference between a current target internal resistance and said first stored value or said initial average stored value exceeds a predetermined value; and

          warning means that generates a error warning output in  
30 response to judgment of said deterioration detecting means.

8. The engine control system according to claim 6, further comprising:

appropriate resistance range data stored in said standard  
5 characteristic storage memory to regulates an allowable variation range of the internal resistance when temperature of said exhaust gas sensor is high; and

error detecting means for judging that there is any error in  
said exhaust gas sensor when said internal resistance is out of said  
10 appropriate resistance range data when said first heater control means makes a heat control of said exhaust gas sensor and makes a control of power application to said electric heater so that the oxygen-concentration data coincide with the standard value data of the oxygen-concentration data in the atmospheric air state stored  
15 in said standard characteristic storage memory;

wherein an error warning output is generated in response to judgment of said error detecting means.

9. The engine control system according to claim 6, further  
20 comprising:

current value evacuating and transferring means that writes and stores the latest stored value or a moving average value of plural target internal resistances read by said calibration signal reading means and stored in said arithmetic memory; and

25 internal resistance reading means for determining an internal resistance of said exhaust gas sensor used as a target value for the control of said electric heater by said second heater control means;

wherein as for the internal resistance read out by said  
30 internal resistance reading means, the latest stored value or the

moving average value obtained from said current value evacuating means is used at normal drive start operation, and said read and stored value or said moving average value of plural values read and stored is used after said calibration signal reading means reads  
5 and stores a new target internal resistance during driving the engine.

10. The engine control system according to claim 9, wherein said standard characteristic storage memory includes temporary  
10 target internal resistance data stored in said standard characteristic storage memory and used until the target internal resistance is calculated by said first heater control means, and said internal resistance reading means reads and uses said temporary target resistance value at first drive start operation for control  
15 of said electric heater by said second heater control means.